A COLLABORATIVE MODEL FOR POST FLOOD ACTIVITIES EXPLOITING AN ENHANCED EXPANDING NEIGHBORHOOD SEARCH ALGORITHM

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We hereby declare that We have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Di antara semua bencana alam, banjir dianggap sebagai bencana yang paling merosakkan tamadun yang menyebabkan kerosakan yang besar terhadap semua kehidupan dan harta benda. Setiap negara mempunyai pasukan penyelamat dan teknik untuk meminimumkan kehilangan dan penderitaan semasa banjir. Komunikasi dan kerjasama merupakan salah satu isu utama bagi operasi pencarian dan menyelamat semasa kejadian banjir. Keupayaan untuk mewujudkan komunikasi dan kerjasama dengan cepat di kalangan penyelamat adalah penting untuk menjalankan misi mencari dan menyelamat (SAR) yang tepat pada masanya dan berkesan. Sistem fizikal siber boleh digunakan untuk menyelesaikan tugas yang mencabar ini, kerana penyelidik menggunakannya dengan jayanya dalam domain yang berlainan. Tesis ini mencadangkan senibina rangkaian dalam bentuk model kolaboratif tanah udara siber (CP-AGCM). Tujuan model ini adalah untuk memperluaskan perkhidmatan kedekatan (ProSe) dan memperluaskan pertukaran maklumat tempatan-global yang bersepadu dalam aktiviti SAR selepas banjir. Dalam model ini juga, memanfaatkan spektrum TV White Space sebagai pautan backhaul rangkaian untuk memperoleh dan menyampaikan data kecemasan pasca banjir. Kaedah utama untuk membangunkan sistem yang dicadangkan dibina atas seni bina berlapis komunikasi tempatan, serantau dan kawasan tanpa wayar, dengan menggabungkan komponen rangkaian kolaboratif di antara lapisan. Fungsian yang diingini CP-AGCM dipamerkan melalui perumusan dan pembangunan strategi carian global yang efisien mengeksploitasikan pelbagai kolaborasi di kalangan ejen rangkaian. Hasil percubaan menunjukkan model kerjasama yang dicadangkan menawarkan platform komunikasi yang lebih berdaya tahan dalam persekitaran banjir yang teruk, dan seterusnya dapat meningkatkan jumlah mangsa yang diselamatkan dalam aktiviti SAR simulasi. Kajian perbandingan menunjukkan prestasi model yang dicadangkan bertambah 30% berbanding dengan model yang sedia ada. Prestasi rangkaian (sebagai contoh, Nisbah penghantaran paket yang mendekati 80-90%) juga menunjukkan keupayaan CP-AGCM untuk menyediakan ProSe dalam senario pasca banjir dan optimum algoritma carian yang efisien.

ABSTRACT

Among all natural disasters, flood is considered as the most civilization-destroying disaster which causes considerable damage to all life and property. Every country has its own rescue teams and techniques to minimize the loss and suffering during the flood. Communication and collaboration are one of the major issues for successful performing search and rescue operations during the flood occurrence. Such as, a crucial problem in post-flood recovery actions is the ability to rapidly establish communication and collaboration among rescuers to conduct timely and effective search and rescue (SAR) missions. The cyber-physical system can be incorporated for solving such a challenging task, as the researchers are exploiting it successfully in different domains. This thesis proposes a novel network architecture in the form of a cyber-physical enabled air-ground collaborative model (CP-AGCM). The aim of this model is to extend the proximity service (ProSe) and expand integrated global-local information exchange in the post-flood SAR activities. In this model, exploiting TV White Space spectrum as network backhaul links for acquiring and communicating post-flood emergency data. The primary method of developing the proposed system builds upon a layered architecture of wireless local, regional and wide-area communications, and incorporates collaborative network components among these layers. The desirable functionalities of CP-AGCM are showcased through formulation and development of an efficient global search strategy exploiting a wide range of collaboration among network agents. The experimental results show the proposed collaborative model offers a more resilient communication platform in harsh flood environments, which in turn can significantly improve the number of rescued victims in the simulated SAR activities. The comparative study demonstrates the performance of the proposed model improves 30% compared to the existing model. The network performance (e.g., packet delivery ratio nearing 80-90%) also demonstrates the capability of CP-AGCM to provide ProSe in the post-flood scenarios and optimality of efficient search algorithm.

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LIST OF SYMBOLS

$P_{Received}$	Received data packet
$P_{Generated}$	Generated data packet
A_i	Arrival time
S_i	Spending time
N_{RP}	Number of routing packets
N_{DP}	Number of delivered packets
ϑ	Number of victims
μ_p	Preparation time
μ_c	Searching time
μ_t	Reach time

LIST OF ABBREVIATIONS

ABS	Aerial Base Station
AMR	Adaptive Multiple Rate
APCO-25	Project 25
AGCM	Air-Ground Collaborative Model
CPS	Cyber Physical System
CP-AGCM	Cyber-Physical enabled AIR-Ground Collaborative Model
CRED	Centre for Research on the Epidemiology of Disasters
CA	Critical Area
DTN	Delay Tolerant Network
D2D	Device To Device
PDO	Packet Data Optimized
DMO	Direct Mode Operation
EM-DAT	Emergency Events Database
ENSA	Expanding Neighborhood Search Algorithm.
FANET	Flying Ad hoc Network
FRTN	Flying Real-Time Network
GPS	Global Positioning System
GSM	Global System for Mobile
GNSS	Global Navigation Satellite System
GPU	Global PDM Update.
GM	Global-Memory.
LTE	Long Term Evaluation
LM	Local Memory
LKP	Last Known Position
LOU	Local PDM Update
LADTR	Location-Aided Delay Tolerant Routing
LV	Land Vehicle
LCA	Land Covered Area
MANET	Mobile Ad hoc Network
MCPTT	Mission-Critical Push To Talk
NS-2	Network Simulator Two
NM	No Memory
NPU	No PDM Update
NAVSTAR	NAVigation Satellite Time and Ranging

PMR	Professional Mobile Radio
PTT	Push To Talk
PDM	Probability Distribution Map
PSA	Probabilistic Search Algorithm
PLS	Point Last Seen
QoS	Quality Of Service
RFID	Radio-Frequency Identification
RRH	Remote Radio Head
RBE	Recursive Bayesian Estimator
RSA	Random Search Algorithm
SAR	Search and Rescue
TVWS	Television White Space
TVBD	Television Band Device
TETRA	Terrestrial Trunk Radio
TETRAPOL	Terrestrial Trunk Radio Police
TEDS	TETRA Enhanced Data Service
TMO	Trunked Mode Operation
TC	Tropical Cyclone
UMTS	Universal Mobile Telecommunications System
UHF	Ultra High Frequency
UE	User Equipment
UAV	Unmanned Air Vehicle
VHF	Very High Frequency
V2V	Vehicle To Vehicle
V2I	Vehicle To Infrastructure
VSAT	Very Small Aperture Terminal
VP	Victim Point
WSN	Wireless Sensor Network
WLC	Wireless Local Communication
WRC	Wireless Regional Communication
WAN	Wide Area Network
WV	Water Vehicle
WCA	Water Covered Area
3D	Three Dimensional

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